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WATER RESOURCES STUDY, PLATTE RIVER BASIN, IOWA AND MISSOURI. (STUDY OF POTENTIAL NEEDS AND VALUE OF WATER STORAGE FOR MUNICIPAL, INDUSTRIAL, AND QUALITY CONTROL PURPOSES)

Public Health Service
Kansas City, Missouri

March 1964

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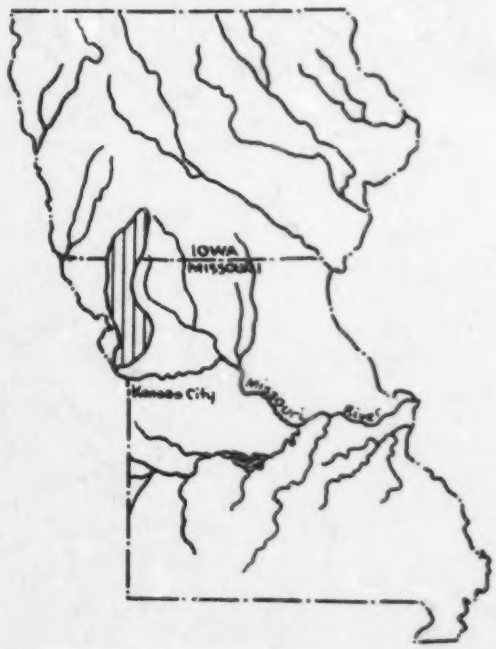
WATER RESOURCES STUDY
PLATTE RIVER BASIN
IOWA AND MISSOURI

Study of Potential Needs and Value of Water Storage for Municipal, Industrial, and Quality Control Purposes



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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VI
Kansas City, Missouri

51

WATER RESOURCES STUDY

PLATTE RIVER BASIN

(Missouri and Iowa)

Prepared for

DEPARTMENT OF THE ARMY

U. S. Army Engineer District

Kansas City, Missouri

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VI
Kansas City, Missouri

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Environmental Protection Agency

(no LC number)

I. INTRODUCTION

Authority

In a letter dated March 9, 1962, the Kansas City District of the Corps of Engineers requested that the Public Health Service: ".... make an investigation of the Platte River Basin (Missouri and Iowa) covering the present and prospective needs for municipal and industrial water supply and for the regulation of streamflow for pollution abatement and water quality control."

This study has been made in accordance with the Memorandum of Agreement dated November 4, 1958, between the Department of the Army and the Department of Health, Education, and Welfare, relative to the Water Supply Act of 1958 (Title III of Public Law 85-500) and the Federal Water Pollution Control Act of 1956, both as amended by P.L. 87-88.

Purpose and Scope

The purpose of this study is to determine the need for and value of storage for municipal and industrial water supply and quality control in the Platte River Basin which is 2,440 square miles and is located in northwest Missouri and southwest Iowa. The study covers water storage needs and values during the 100-year study period, 1970 to 2070, as requested by the Corps of Engineers.

Acknowledgments

This study was made possible through the cooperation and assistance of the following Federal, State and local agencies:

1. Iowa State Health Department, Environmental Sanitation Division, Des Moines, Iowa
2. Missouri Division of Health, Jefferson City, Missouri
3. Missouri State Geological Survey, Rolla, Missouri
4. Missouri Water Pollution Control Board, Jefferson City, Missouri
5. Corps of Engineers, Kansas City District, Kansas City, Missouri
6. Municipal Officials -
   a. St. Joseph, Missouri
   b. Maryville, Missouri
   c. Savannah, Missouri
   d. Creston, Iowa
7. St. Joseph, Missouri Water Company

II. SUMMARY AND CONCLUSIONS

Summary

1. The Corps of Engineers is making a study of the Platte River Basin to determine the feasibility of constructing multipurpose reservoirs.

2. The study area is the Platte River Basin located in south central Iowa and northwestern Missouri, including Taylor, Ringgold, Union, and Adams Counties in Iowa and Platte, Clay, Buchanan, Clinton, Andrew, DeKalb, Gentry, Nodaway, and Worth Counties in Missouri.

3. The area of the Platte River Basin is 2,440 square miles.

4. Population of the study area was 277,500 in 1960 of which 172,830 were urban and 104,670 were rural. County populations were used in the economic section.

5. The principal communities in the basin and their 1960 population are: Creston, Iowa - 7,667; Bedford, Iowa - 1,807; Maryville, Missouri - 7,807; Platte City, Missouri - 1,118; Smithville, Missouri - 1,254; and Plattsburg, Missouri - 1,663.

6. Average daily 1963 water use from municipal water supplies in the basin amounts to 2.34 mgd (million gallons per day) to supply a population of 27,840, or an average per capita use of approximately 84 gpcd (gallons per capita per day).

7. The raw wastes produced at Bedford are 4,000 P.E. (population equivalents), 7,500 P.E. at Creston, 6,700 P.E. at Maryville, 1,200 P.E. at Smithville, 1,070 P.E. at Platte City, and 1,300 P.E. at Plattsburg.

8. In determinations of water needs, the Platte River Basin is divided into upper and lower areas. Nodaway County, Missouri, and all

of the Platte River Basin to the north of Nodaway County is the upper area. The remaining portion of the Platte River Basin is the lower area.

Conclusions

1. The urban population in the nine-county study area used for economic projections will grow from a population of 280,000 persons in 1960 to 500,000 persons by 2020 and 800,000 persons by 2070.

2. Based on economic projections the municipal and industrial water demands in the upper and lower areas will increase as follows:

	Upper Area MGD	Lower Area MGD
1970	2.1	3.6
2020	6.3	16.3
2070	15.4	46.2

3. The municipal and industrial water demand in the upper area which cannot be met by natural streamflow or ground water sources will be 2.1 mgd by 2070. The value of storage in the upper area to meet the municipal and industrial water demands, which natural runoff does not supply, is $6,300 per year. The annual cost was discounted to 1970 from 2015, the year of first need. Refer to Section VII.

4. The municipal and industrial water demand in the lower area which cannot be met by natural streamflow or ground water sources will be 22.6 mgd by 2070. The value of storage in the lower area to meet the municipal and industrial water demands which natural runoff does not supply is $335,000 per year. The year of first need is 1970. Refer to Section VII.

5. Maintenance of satisfactory water quality in the Platte River basin will benefit a wide spectrum of water uses in the study area. By 2070, 800,000 people will live in the area which will benefit through streamflow regulation by the improvement of water quality in approximately 350 river miles of stream in the basin. Municipal and industrial raw water supplies of satisfactory quality will be available. Water treatment cost will not be increased. Municipal growth will be advanced by an adequate water supply. Recreational opportunities, including fishing, swimming, water skiing, and boating will be increased. The esthetic values of the stream stemming from clean surface waters, a satisfactory public health water environment, and preservation of property values in areas contiguous to the stream will thereby be assured. These widespread benefits may be credited to storage for water quality control only if assurance is given that adequate treatment of wastes will be provided.

6. A total draft on storage of 14,700 acre-feet per year above reservoir inflow will be needed for quality control by 2070 in the lower area. Costs were discounted from the year of first need, 2040 to 1970. The annual value of storage in the lower area for quality control is $12,900. Refer to Section VIII.

7. Total draft on storage above reservoir inflow of approximately 10,300 acre-feet per year will be needed for quality control by 2070 in the upper area. An annual draft on storage of 7,700 acre-feet for quality control will be needed by 2070 above Bedford for wastes from Bedford and Maryville. The average value of storage for quality control for Bedford

and Maryville wastes is $12,500. The year of first need is 1970. An annual draft on storage of 2,640 acre-feet for quality control will be needed by 2070 for wastes from Creston. The year of first need is 1970. The average annual value of storage for quality control for Creston wastes is $93,700. Refer to Section VIII.

III. PROJECT DESCRIPTION

Location

The main stem of the Platte River rises in Union County, Iowa, near Creston, Iowa, and flows in a southerly direction for about 250 river miles, emptying into the Missouri River below Leavenworth, Kansas. The river system is north and east of the Missouri River and drains 2,440 square miles in southwestern Iowa and northwestern Missouri. See Map of Study Area in Section IX.

Streamflow

Approximately 100 miles of the upstream reaches of the Platte and One Hundred and Two Rivers have been improved by local drainage districts resulting in faster travel times and larger channel capacities than exist downstream where the channel slope is flatter and the stream follows a more sinuous course.

Flows in the Platte River and its tributaries are extremely variable. The basin is located in an area which is subject to rather frequent severe thunderstorms and also to frequent periods of no flow even in downstream reaches.

Records of the Platte River for the station at Agency, Missouri, (drainage area 1,760 square miles) show that instantaneous flow measurements have ranged from 50,000 to 0 cfs with the mean flow for 33 years of record being 783 cfs. Historical streamflows in the basin are presented in Exhibit No. 1

Water Quality

There are no long range chemical quality records of surface waters in the Platte River basin. Table No. III-1 shows representative quality data of surface water in the area as reported by the Missouri Division of Health for 1962, and the Iowa Department of Health for the years 1957 to 1962.

Table No. III-1

Mineral Solids Concentrations of Surface Water
(Concentrations in Milligrams per Liter (mg/l))

Platte River Basin (Missouri & Iowa)

Constituent	Maximum	Minimum
Total Dissolved Solids	431	133
Hardness ($CaCO_3$)	228	88
Chlorides (Cl)	19	< 0.5
Sulfates (SO_4)	142	17
Nitrates (N)	1.0	0.4

The chemical concentrations are below the stated 1962 Public Health Service Drinking Water Standards (limits not to be exceeded).

Watershed Work Plan [17/]

The Watershed Work Plan for 102 River Tributaries Watershed, State of Missouri, has been developed. The watershed is approximately 8 miles long and 4 miles wide, located between the cities of Pickering on the north and Maryville on the south in Nodaway County, Missouri. The watershed includes tributary drainage from both sides of the 102 River. Ten Grade Stabliization Structures are presently (August 1963) included in the watershed work plan affecting a drainage area of 3,693 acres.

IV. DESCRIPTION OF STUDY AREA

Location and Boundaries

The Platte River Basin is located between the Nodaway River Basin and the Grand River Basin in northwestern Missouri and south central Iowa. The total drainage area is 2,440 square miles, of which 786 square miles are in Iowa and 1,654 square miles are in Missouri. The basin is about 135 miles long by 28 miles wide.

The length and drainage area of the main stem and principal tributaries, proceeding in order upstream as shown in the map of the area, are listed in the following table.

Table No. IV-1

Length and Drainage Areas of the Principal Streams

Platte River Basin Study Area

Stream	Length* (Miles)	Drainage Area (Square Miles)
Little Platte River	58	311
White Cloud Creek	40	69
Castile Creek	46	170
Third Fork Platte River	50	240
102 River	111	780
Honey Creek	45	97
Platte River	250	2,440

*Estimated

The study area is defined as those portions of the Platte River Basin that are located in Platte, Clay, Buchanan, Clinton, Andrew, DeKalb, Gentry, Nodaway, and Worth Counties in Missouri, and Taylor, Ringgold, Union and Adams Counties in Iowa.

Geography and Topography

Land elevations in the Platte River Basin range from approximately 1,320 feet in the headwaters area near Creston, Iowa, to 760 feet above mean sea level at the junction of the Platte River with the Missouri River.

Topographic features of the basin may be divided into two distinct types: (1) the uplands area, and (2) the river bottom lands. The uplands range from nearly level to undulating and rolling. The divides are narrow and flat and numerous draws assure thorough and sometimes even excessive drainage. 9/ The bottomlands are usually quite flat and lie at a low elevation above the stream so that they are subject to frequent inundation. The Platte River is a very tortuous stream, but a large part of the main stem above Agency, Missouri, and some of the larger tributaries have been artificially straightened, either by occasional cutoffs or by entirely new channels.

Climate

Climate of the Platte River Basin is characterized by hot summers and moderately cold winters. Rainfall in the Platte River Basin varies from an average of approximately 32 inches per year on the northern edge of the basin to approximately 36 inches per year near the lower end of the basin.

Average annual temperature in the basin is approximately 51° F with extremes of approximately 115° F and -25° F being recorded. The frost-free growing season in the basin is approximately 180 days.

V. ECONOMY

The projected economic development is the basis of the future municipal and industrial water requirements and waste loads on which quality control requirements are determined. To efficiently develop the water resources for competitive uses and effectively supply the present and projected needs of the study area, the past and present economic conditions were investigated.

Past and Present

For statistical interpretation the study area for the economic investigation was defined as the entire counties of Clay, Platte, Buchanan, Clinton, Andrew, DeKalb, and Nodaway in Missouri and Union and Taylor in Iowa.

In 1960, the economy of the Platte River study area was dependent, in order of importance, upon the services, manufacturing, agriculture, and mining. Of the 108,506 persons in the labor force, 70,369 or 65 percent were employed in the services, 21,820 or 20 percent were employed in manufacturing, 12 percent or 12,488 were employed in agriculture and less than one percent was employed in mining. The remaining three percent of the labor force was unemployed. See Table No. V-1.

Manufacturing contributes significantly to the economy by employing the largest number of basic workers in the study area. The largest number employed in manufacturing is in the food and kindred product industries. Table No. V-2 shows employment data by manufacturing categories.

Table No. V-1

The Number and Percentage of the Labor Force [1/]
by Major Classifications in the Platte River Study Area
1940 - 1950 - 1960

	1940		1950		1960	
	Number	Percent of Labor Force	Number	Percent of Labor Force	Number	Percent of Labor Force
Farm	23,248	26	19,838	21	12,488	12
Mining	470	1	182	-	258	-
Manufacturing	10,370	11	16,404	18	21,820	20
TOTAL BASIC	34,088	38	36,424	39	34,566	32
TOTAL SERVICE	49,129	55	53,946	58	70,369	65
UNEMPLOYED	6,813	7	2,795	3	3,571	3
TOTAL LABOR FORCE	90,030	100	93,165	100	108,506	100

Table No. V-2

Manufacturing Employment by Industrial [1/]
Sub-Classifications for the Platte River Study Area
1940 - 1950 - 1960

	1940	1950	1960
Manufacturing	10,370	16,404	21,820
Furniture, Lumber, and Wood Products	330	416	424
Primary Metals	614	337	417
Fab. Metals, Mach., Vehicles, Other Durables	632	3,391	6,650
Food and Kindred Products	5,291	7,418	7,893
Textile and Apparel	1,075	1,333	1,432
Printing and Publishing	915	1,166	1,500
Chemicals and Allied Products	396	711	1,359
Other Nondurables	1,117	1,632	2,145

The manufacturing category has been increasing in employment over the past 20 years. In 1940, slightly over 10,000 were employed in manufacturing; this employment increased to almost 22,000 by 1960. Increases in manufacturing are also revealed in number of establishments and value added by manufacturers. Table No. V-3 depicts manufacturing trends.

Table No. V-3

Manufacturing Data for the Platte River Study Area 2/

1948 - 1954 - 1958

	Number of Establishments	Value Added by Mfg.*
1947	248	$131,880
1954	291	$185,130
1958	313	$235,920

*Adjusted to the 1959 value of the dollar.

Agricultural employment had a sharp decrease from 23,237 in 1940 to 12,488 in 1960. The number of farms has also been decreasing from 16,943 in 1949 to 13,101 in 1959; however, during this period the dollar value of all farm products sold has increased from about $94 million to approximately $107 million (adjusted to the 1959 value of the dollar). Increases in agricultural technology and farm consolidation have been largely responsible for the decreasing farm labor force and increasing production. Table No. V-4 depicts agricultural data for the study area.

Table No. V-4

Agricultural Data for the [1,3/]

Platte River Study Area

1949 - 1954 - 1959

	Number of Farms	Cropland Harvested (Acres)	Value of all Farm Products Sold* (Million Dollars)
1949	16,943	1,298,974	93.6
1954	15,209	2,210,030	82.5
1959	13,101	1,149,335	107.4

*Adjusted to the 1959 value of the dollar

The total population of the study area has increased approximately 20 percent, from 232,622 in 1910 to 277,500, in 1960. During this period, the rural portion decreased from 130,693 to 104,670 while the urban part increased from 101,929 to 172,830. A large part of this urban increase is in Clay County, which is located in the Kansas City SMSA. The population of Clay County increased from 20,302 to 87,474 from 1910 to 1960. St. Joseph SMSA which is in the economic study area lost population over the past 50 years, decreasing from 93,020 in 1910 to 90,581 in 1960. Table No. V-5 depicts population data for the study area by counties from 1910 to 1960.

Table No. V-5

Platte River Study Area

Population Data 5/

1910 - 1960

STATE County	1910	1920	1930	1940	1950	1960
IOWA						
Taylor	16,312	15,514	14,859	14,258	12,420	10,288
Union	16,616	17,268	17,435	16,280	15,651	13,716
MISSOURI						
Andrew	15,282	14,075	13,469	13,015	11,727	11,062
Buchanan (St. Joseph SMSA)	93,020	93,684	98,633	94,067	96,826	90,581
Clay (Part of Kansas City SMSA)	20,302	20,455	26,811	30,417	45,221	87,474
Clinton	15,297	14,461	13,505	13,261	11,726	11,588
DeKalb	12,531	11,694	10,270	9,751	8,047	7,226
Ncdaway	28,833	27,744	26,371	25,556	24,033	22,215
Platte	14,429	13,996	13,819	13,862	14,973	23,350
Total Study Area	232,622	228,891	235,172	230,467	240,624	277,500
Urban	(101,929)	(104,442)	(112,558)	(107,678)	(128,952)	(172,830)
Rural	(130,693)	(124,449)	(122,614)	(122,789)	(111,672)	(104,670)

Future

The presence of the St. Joseph SMSA in the study area and the proximity of Kansas City should have the most significant effect on the future growth in the study area. Projected population growth 6,7,8/ in these metropolitan areas should affect the study area in terms of increased manufacturing and agricultural production. Refer to Table No. V-6 for employment projections.

Manufacturing employment in the study area is projected to increase from approximately 22,000 in 1960 to about 44,000 in 2020 and 62,000

in 2070. The major increases should be in the categories of food and kindred products, fabricating metals, machinery and vehicles. The major part of this employment should be absorbed in Clay and Buchanan Counties.

Agricultural production in the study area should continue to increase. A large portion of this increase should be consumed in St. Joseph and Kansas City SMSA's. A continual increase in farm technology should result in continual decrease in farm employment, dropping from 12,000 in 1960 to 8,000 in 2070.

The total population of the study area is expected to continue to increase but at a slightly higher rate, increasing from about 280,000 in 1960 to 500,000 in 2020 and 800,000 in 2070. The urban sector should increase from about 170,000 in 1960 to about 400,000 in 2020 and 710,000 in 2070. The largest portion of this growth should be absorbed by the St. Joseph and Kansas City SMSA's. The rural sector is expected to decrease from about 105,000 in 1960 to 100,000 in 2020 and 90,000 in 2070. Exhibit No. 2 displays population projections for the study area. (These population projections were based primarily on projections made by Federal and local agencies.) [6,7,8/]

Projected population and industrial growth will be accompanied by an increase in municipal and industrial water need and a corresponding increase in waste discharges. The effect on water supply and water quality control needs is covered in the following section.

Table No. V-6

Projected Employment of Labor Force

Platte River Study Area

2020 - 2070

	2020		2070	
	Number (Thousands)	Percent of Labor Force	Number (Thousands)	Percent of Labor Force
Farm, Forestry & Fisheries	10.0	5	8.0	3
Mining	.5	-	1.0	-
Manufacturing	43.8	24	62.0	21
TOTAL BASIC	54.3	29	71.0	24
TOTAL SERVICE	130.0	68	220.0	73
UNEMPLOYED	5.7	3	9.0	3
TOTAL LABOR FORCE	190.0	100	300.0	100
TOTAL POPULATION	500.0		800.0	

VI. WATER RESOURCES

Surface Water

Streamflows in the Platte River are extremely variable. The table of Historical Streamflows (Exhibit No. 1) shows that the flow at Agency (drainage area 1,760 square miles) has ranged from a flood flow of 50,000 cfs down to periods of no flow. The periods of no flow are relatively infrequent. During the periods of record, 1924 to 1930 and 1932 to 1962, there was no flow at times in July and August of 1934 and October of 1956.

Streamflow data on the One Hundred and Two River (drainage area 500 square miles) near Maryville, Missouri, show that the flow has ranged from a flood flow of 14,200 cfs down to periods of no flow during the 1932-61 period. There was no flow at times in August and September 1934; July 25-26, 1940; January 28-30, 1954, and for part of each day July 29, 30, 1960, which was caused by temporary storage behind a dam built to direct flow into a new channel.

After conventional treatment, the quality of the surface water in the basin is satisfactory for most municipal and industrial purposes. The chemical concentrations are below the 1962 Public Health Service Drinking Water Standards (limits not to be exceeded). Typical chemical analyses of surface and ground waters in the basin are shown in Exhibit No. 4. The raw water analyses at Bedford, Iowa, using water from the One Hundred and Two River show chlorides as 10 milligrams per liter (mg/l), sulfates 123 mg/l, total dissolved solids 341 mg/l, and hardness 228 mg/l.

Ground Water

Ground water in the Platte River basin is in two distinct categories. Many of the private wells and a few municipal supplies are obtained from the glacial drift which overlays the basin. In general water from the glacial drift is high in iron, total dissolved solids, and sulfates. In addition to the high mineral content of this water, there are only limited small areas in the basin where wells in the glacial drift yield sufficient water for municipal supplies.

Many private wells in the basin draw their water from the consolidated rock formations which underlie the area but these wells provide only limited yields of water of marginal quality. Water from the consolidated rock formations usually is more mineralized at increased depths.

An example of the high mineral concentrations of ground water is the municipal supply at Hopkins, Missouri. Total dissolved solids are 806 mg/l, sulfates 214 mg/l, hardness 480 mg/l, and chlorides 71 mg/l.

Ground water yield from the alluvial material along the lower Platte River is sufficient for municipal and industrial water supplies and is of satisfactory mineral quality. The municipal supply at Platte City, Missouri, is an example of the water taken from the alluvial material with total dissolved solids of 179 mg/l, sulfates 44 mg/l, hardness 106 mg/l, and chlorides 16 mg/l. Refer to Exhibit No. 4.

VII. MUNICIPAL AND INDUSTRIAL WATER SUPPLY NEEDS

Present

Seventeen municipal water supply facilities in the Platte River Basin serve approximately 27,840 persons with an average of 2.4 mgd (million gallons per day). The average per capita per day use in the Basin is 84 gallons. Details of municipal demands are shown in Exhibit No. 3 of the Appendix.

Nine municipalities have ground water supplies and eight have treated surface water supplies from impoundments. Approximately 0.3 mgd is used from wells and 2.0 mgd from surface supplies.

The mineral concentrations of the surface water supplies are less than those stated in the 1962 Public Health Service Drinking Water Standards (values not to be exceeded). Four of the well supplies have mineral concentrations in excess of the 1962 Public Health Service Drinking Water Standards. Typical chemical analyses of municipal water supplies are shown in Exhibit No. 4 of the Appendix.

Prospective

In projecting water demands, the basin was divided into upper and lower areas because there is expected to be more light industrial development in those portions of the basin that are near Kansas City and St. Joseph. The upper basin area is in Adams, Union, Ringgold, and Taylor Counties in Iowa and Nodaway and Worth Counties in Missouri. The lower area is in the Counties of Clay, Platte, Buchanan, Clinton, Andrew, DeKalb, and Gentry, Missouri.

The future municipal, rural, and industrial water supply require-

ments in the Platte River Basin are indicated for the base period of 1970 and future periods of 2020 and 2070.

The increase in municipal and industrial water requirements during the study period is based on population growth, industrialization, commercialization, and development of new water-using devices for the home. The upper area is expected to have a steady light industrial and commercial growth. The lower area near Kansas City and St. Joseph is expected to have greater commercial and light industrial development and therefore greater water use per capita.

Table No. VII-1 indicates the expected water use expressed in gpcd for the two areas. The figures include light water using industries and commercial establishments.

Table No. VII-1

Water Demand
(gpcd)

Platte River Basin Study Area (Missouri & Iowa)

	1970	2020	2070
Upper Area	110	140	190
Lower Area	130	160	210

The areas are supplied by ground and surface water sources. The municipal and industrial water demands for the upper area are expected to reach 2.1 million gallons per day (mgd) by 1970, 6.3 mgd by 2020, and 15.4 mgd by 2070. The total municipal and industrial water demands for the lower area are expected to reach 3.6 mgd by 1970, 16.3 mgd by 2020, and 46.2 mgd by 2070.

A resolution was passed by the Kansas City, Missouri Council January 3, 1964, requesting the Corps of Engineers to include 60,000 acre-feet of water supply storage or such greater amounts of storage as may be possible in the project for its future water supply needs. Kansas City officials have indicated that the water from storage in a reservoir in the lower basin will be needed by approximately 1968 to meet their estimated water supply needs.

The expansion of present water supply facilities and the development of storage on the Little Platte River for municipal and industrial water supplies are expected to satisfy the municipal and industrial water demands in the lower area including parts of the Kansas City SMSA's estimated requirements. The time of first need is approximately 1970.

In the upper area storage for municipal and industrial water will be needed by 2015.

The larger communities in the upper area are: Creston (1960 population 7,667), Bedford (1960 population 1,807), and Lenox (1960 population 1,178) in Iowa, and Maryville (1960 population 7,807) in Missouri. The Iowa communities are in the headwaters of the basin and all use surface water. Bedford has an impoundment on the East Fork of 102 River and also has a pipeline to the Lake of Three Fires. The city uses water from the lake when necessary. Lenox and Creston both have impoundments on headwater streams. Present information indicates that all of these Iowa communities have adequate water supplies.

Maryville, Missouri, pumps water from an impoundment on the 102 River. Based on population projections and an increase in gallons per capita per day water usage, Maryville will need additional water by 2015. By 2070, Maryville will need a draft on storage of 2.1 mgd.

Value of Storage

In the upper area water supply needs could be met from either a single purpose reservoir or a dual purpose reservoir. (The dual purpose reservoir considered would serve as a source of water for both municipal and industrial water and streamflow regulation for quality control.) A cost analysis indicated that the single purpose reservoir on 102 River above Maryville would be needed by 2015. The single purpose reservoir was found to be the more economical.

The reservoir would need to be able to sustain a draft on storage of 2,320 acre-feet/year in addition to reservoir inflow to meet the 2070 municipal and industrial water supply needs. Considering evaporation and sedimentation, this single purpose reservoir should have a total storage capacity of approximately 4,400 acre-feet. Senate Select Committee Print No. 32 cost of construction figures were used to estimate cost of this single purpose alternative. The estimated total construction cost is $680,000. The annual value for storage for municipal and industrial water supply in the upper area is $6,300. For details see Exhibit No. 6.

In the lower area water supply needs could be met by obtaining water from the Missouri River or from a reservoir in the Platte River basin.

Treatment costs of Platte River basin water and Missouri River water are assumed to be equal because limited data indicate the chemical quality of the waters is similar. A cost analysis indicated that a single purpose reservoir plus a treatment plant on the Little Platte River would be more economical. A single purpose reservoir on Little Platte River above Smithville would be needed by approximately 1970.

The proposed reservoir should be able to sustain a draft on storage of 20,300 acre-feet/year in addition to reservoir inflow to meet the 2070 municipal and industrial water supply needs. Considering evaporation and sedimentation, this single purpose reservoir should have a total storage capacity of 85,000 acre-feet. Senate Select Committee Print No. 32 cost of construction figures were used to estimate the cost of this single purpose alternative. The estimated total construction cost of the reservoir is $5,100,000. The estimated construction cost of the treatment plant is $4,400,000. The total estimated cost of the alternative in the lower area is $9,500,000. This cost is less than the alternate of constructing a plant on the Missouri River and pumping the water to the area requiring the additional supply. The annual value for storage for municipal and industrial water supply in the lower area is $335,000. See Exhibit No. 6 for the computations of municipal and industrial water supply benefits.

VIII. STREAMFLOW REGULATION FOR WATER QUALITY CONTROL

General

Under provisions of the Federal Water Pollution Act, Public Law 84-660, as amended by P.L. 87-88, in the survey or planning of a reservoir by any Federal agency, consideration must be given to the inclusion of storage for regulation of streamflow for the purpose of water quality control. The law expressly states that any such storage and water releases shall not be provided as a substitute for adequate treatment or other methods of controlling wastes at their sources.

Discharge of wastes, even when treated to the maximum economically feasible and practical limit, will cause an unsatisfactory quality condition in receiving waters whose waste assimilation capacity is exceeded. This condition usually, but not always, occurs during periods of low flows and may be avoided by the addition of water to maintain flows at higher levels. Recognition must be given to the need for required flows in receiving streams if the water quality is to be maintained at acceptable levels.

The quality objectives are based on total dissolved solids (TDS), sulfates (SO_4), chlorides (Cl), and dissolved oxygen (DO). The limits for TDS, SO_4, and Cl are those stated in the 1962 Public Health Service Drinking Water Standards of not greater than 500, 250, and 250 mg/l, respectively. The storage provided for streamflow regulation will maintain D.O. concentration in the order of 5-6 mg/l, or higher, except for one year out of ten, when the dissolved oxygen will drop to a minimum of 4mg/l at the point in receiving waters where the maximum effect of pollution is felt.

Basic data indicating the present sources of domestic and industrial pollution appear in the Appendix as Exhibit No. 5.

Present

Based on projected economic activity mineral solids concentrations will continue to meet U. S. Public Health Service Drinking Water Standards and water quality control to maintain these objectives will not be required. (Note: In the absence of allocation of storage for irrigation, no consideration has been given to the effects of irrigation return flows on water quality.)

As populations increase so will waste loadings discharged. Even with adequate treatment, which is defined as 85 percent removal of biochemical oxygen demand in this study, waste residuals reaching the river exceed its assimilative capacity in the first year of the study period (1970) to the point that a dissolved oxygen concentration of 5 mg/l cannot be maintained under critical conditions. Considering the need for water quality control, a degree of 90 percent represented by a 10 percent probability of flows being equal to or less than those provided for has been used to estimate water quality control storage needs.

Prospective

Future waste loadings in the Platte River basin have been estimated on the basis of population growth projections and on the projected increase in municipal water demands. Few waste problems are expected from recreation. It is assumed that all municipalities will have adequate treatment. Table No. VIII-1 presents the main factors used in estimating the future pollution loads in the study area.

Table No. VIII-1

Waste Loading Projection Factors

Platte River Basin Study Area

	1970	2020	2070
Municipal Water Demand (GPCD)			
Upper Area	110	140	190
Lower Area	130	160	210
Municipal Return (percent)	70	70	70
Organic Load per Population Equivalent (pounds ultimate first stage BOD)	0.25	0.25	0.25
BOD Removal Efficiency (percent)	85	85	85

The pollutional effect of waste discharges on a receiving stream is a function of a number of variables. The main assumptions used in evaluating the need for quality control storage or regulation below the three proposed reservoirs in the Platte River basin are enumerated below:

1. Characteristic of waste discharged to the stream will continue to be primarily organic in nature.

2. Specific mineral and/or organic toxicants will not be a significant problem.

3. Considering the needs for water and the cost of providing this water, a degree of protection of 90 percent, represented by a 10 percent probability of flows being equal to or less than those provided for, will be reasonable in this area.

4. Maintenance of a minimum concentration of 5 mg/l dissolved oxygen will provide reasonable protection for fish and other aquatic life and is in accordance with the objectives of the Missouri Basin Engineering Health Council.

5. Quality control needs were based on three different periods. The summer period is assumed to be five months long and to have an average water temperature of 24°C. The winter period is assumed to be four months long and to have an average water temperature of 5°C. The spring and fall periods are assumed to be three months long and to have an average water temperature of 15°C.

6. Streamflow regulation requirements are based on the assumption that the water released from reservoir for quality control will have an oxygen content equal to or greater than the oxygen content of the natural streamflow at 80 percent saturation.

Quality control needs are based on the minimum dissolved oxygen concentration of 5 mg/l and were determined for the major streams for the summer, winter, and spring and fall seasons. The graphical solution of the oxygen-sag equation was used to determine the quality requirements at Bedford, Maryville, Creston, Smithville, and Platte City. The table below gives the flow required in the stream to meet the above quality requirements.

Table No. VIII-2

Minimum Streamflow for Quality Control
(mgd)

Platte River Basin Study Area

	1970			2020			2070		
		Spring			Spring			Spring	
Municipality	Summer	& Fall	Winter	Summer	& Fall	Winter	Summer	& Fall	Winter
102 RIVER									
Bedford	2.7	1.1	0.4	6.6	2.6	1.0	12.7	4.8	1.8
Maryville	4.4	2.3	1.2	12.4	5.8	2.1	21.1	9.7	4.4
PLATTE RIVER									
Creston	3.7	1.6	0.7	8.8	3.5	1.8	16.4	7.0	4.1
Platte City & Smithville	3.9	1.5	0.7	51.7	16.3	7.9	153.0	39.3	21.4

Considering quality control needs, municipal returns, and natural runoff (based on the 90 percent protection level), Table No. VIII-3 lists the annual draft on storage in addition to the reservoir inflow needed in 2070 to maintain the quality objectives in each reach where there is a quality control need. A schematic diagram of the river systems is shown in Figure No. VIII-1.

Table No. VIII-3

Summary of Net Regulation Requirements
in Acre-Feet per Year in 2070

Platte River Basin Study Area

Area	Draft on Storage
Lower Area	14,700
Upper Area	
Below Creston	2,640
Above Bedford	7,664

The draft on storage shown in Table No. VIII-3 are the releases above natural reservoir inflow to meet the quality objectives in each area. There is a need for quality control water in the upper area in 1970. In the lower area shown in Table No. VIII-3, there is a need for quality control by 2040. Some problems may arise from pollution loads entering the reservoirs and special studies or investigations may be needed.

Benefits

Benefits attributable to storage for streamflow regulation for water quality control may be tangible, i.e., may have a measurable dollar value or may be intangible with no measurable dollar value.

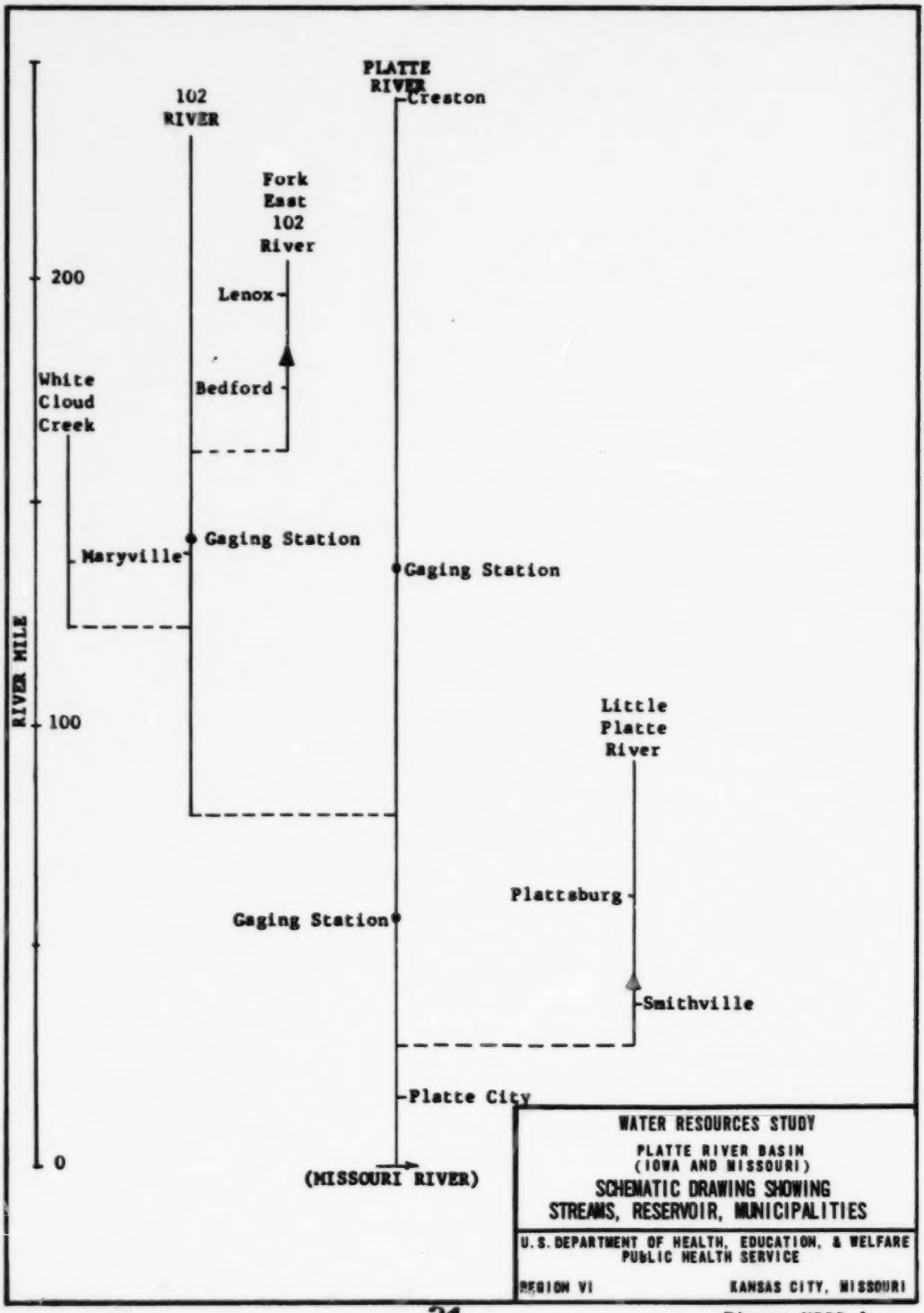

Figure VIII-1

Representing the former, water quality control management of reservoirs in the Platte River Basin will provide recreational opportunities for a distance of approximately 350 river miles from the dams to the confluence of the Platte River with the Missouri River above Kansas City, Missouri, and provide some quality improvement of the Missouri River below its confluence with the Platte River.

Assured water quality will provide favorable conditions for recreation such as swimming, water skiing, boating, and fishing for those living in the Platte River Basin and in nearby areas. The total population of the study area is estimated to be in the order of 800,000 by 2070. It is not unreasonable to anticipate that the total population in the study area including the people located in the Kansas City and St. Joseph SMSA's will be able to enjoy the recreational opportunities offered.

In addition to recreational benefits, and falling into the intangible benefit category, riparian property owners will enjoy improved esthetics of the stream stemming from clean surface waters and a satisfactory public health water environment. Availability of water of more uniform quality, as well as quantity, is a strong attraction to water-using industries, hence, industrial growth will be favored. It is entirely possible that impoundments will have a beneficial effect on the mineral solids content of the waters of the controlled streams, which could lower treatment costs. Benefits will be realized over practically the entire length of the Platte River, and to a lesser degree, in the Missouri River. From the above, it is concluded that benefits are widespread in scope, and sufficient in magnitude to justify and warrant the provision of the indicated volume

of storage for the required streamflow regulation. These benefits may be credited to storage for the regulation of streamflow for water quality control purposes only if assurance is given that adequate treatment will be provided.

If required storage for streamflow regulation is not provided as recommended, benefits described above will not be realized. Losses will be suffered due to increased water treatment costs, damage to paint on structures adjacent to, or in, the streams and property values will decline in areas contiguous to the streams. Lacking a water supply of assured quality as well as quantity, industry will be most likely to select other plant sites. all other things being equal, which means economic opportunities will be foregone to the portions of the study area that would otherwise be benefited. Recreation will suffer. Without streamflow regulation, it is estimated that the projected waste loads of 300 pounds BOD at Creston will result in a dissolved oxygen concentration of approximately 2.0 mg/l by 1970. This means that aquatic life such as fish will leave the area in favor of waters that more nearly provide the environment they require. By approximately 1985 waste loads will have increased until the dissolved oxygen will reach zero; no fish will be found in the upper stretch of the river, which will become the source of noxious odors and paint blackening fumes. and will be worthless for recreational purposes. As waste loads continue to increase, conditions in the receiving streams will continue to worsen. Unsatisfactory conditions will occur in the lower area by 2040 unless adequate treatment is supplemented by streamflow regulation.

Value of Benefits

When no adequate means can be devised to evaluate directly the economic effects of water quality maintenance or improvement, the cost of achieving the same results by the most likely alternative may be used as an approximation of value. In determining the "most likely alternative" several possibilities have been studied.

In the upper area, holding ponds and a pipeline were the most feasible alternatives for quality control. At Creston, Iowa, 15 miles of pipeline will be needed in 1970, the beginning of the study period. A holding pond for Creston sewage plant effluent will be needed in addition to the pipeline by 2005. The pipeline is needed in the early part of the study to bring the sewage plant effluent downstream to the junction of the West Platte and Platte Rivers. The additional streamflow at this point will be sufficient to maintain 5 mg/l oxygen in the stream until approximately 2005 when a holding pond will also be needed. The holding pond will be used to hold the sewage plant effluents. Releases from the holding pond to the receiving stream will be made at a rate not to exceed the assimilative capacity of the receiving stream.

At Bedford, Iowa, a holding pond will be needed by 1970 and it will have to be reworked or enlarged by 2020. A holding pond will be needed at Maryville by 2005.

The total annual value of the alternatives in the upper area is $106,200 for the duration of the study period 1970 to 2070. See Exhibit No. 7.

In the lower area, either streamflow regulation for quality control or an alternate will be needed by 2040 to maintain the objectives. A

pipeline for delivering the sewage plant effluents to the Missouri River was found to be the most feasible alternative. The total annual value of the alternative in the lower area is $12,900 for the duration of the study period 1970 to 2070. See Exhibit No. 7.

IX. MAP OF AREA

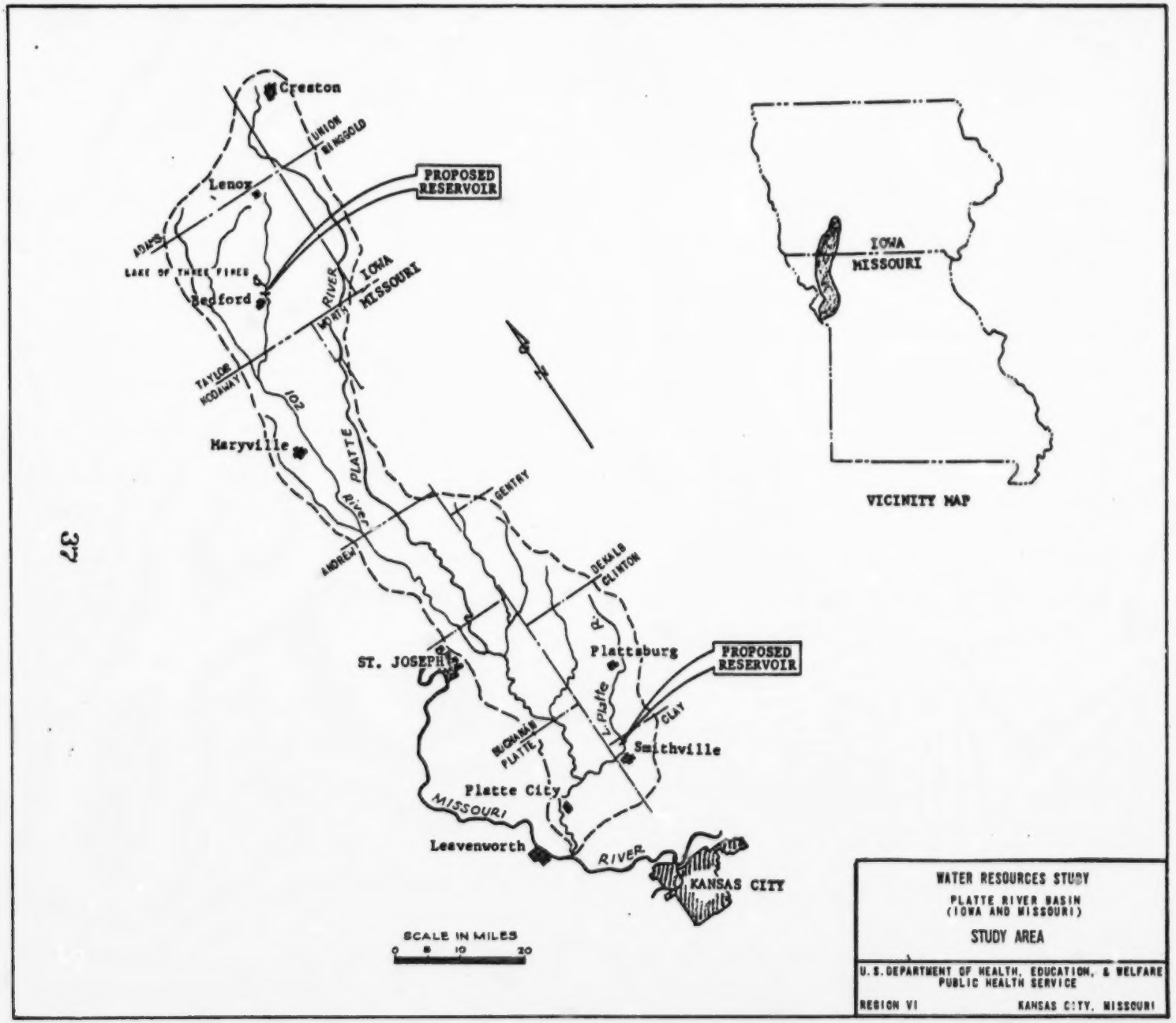
Creston
UNION
RINGGOLD
Lenox
PROPOSED
RESERVOIR
ADAMS
LAKE OF THREE FIRES
Bedford
IOWA
MISSOURI
TAYLOR
NODAWAY
102
Maryville
PLATTE
RIVER
GENTRY
ANDREW
DEKALB
CLINTON
ST. JOSEPH
Plattsburg
PROPOSED
RESERVOIR
L. Platte
CLAY
BUCHANAN
PLATTE
Smithville
Platte City
MISSOURI
Leavenworth
RIVER
KANSAS CITY
SCALE IN MILES
0 5 10 20
IOWA
MISSOURI
VICINITY MAP
WATER RESOURCES STUDY
PLATTE RIVER BASIN
(IOWA AND MISSOURI)
STUDY AREA
U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VI
KANSAS CITY, MISSOURI

Figure IX-1

X. BIBLIOGRAPHY

X. BIBLIOGRAPHY

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XI. APPENDIX

Exhibit No. 1

Historical Streamflows in Platte River Study Area[1]
(Missouri and Iowa)

Station	Location	River Mile*	Years of Record	Flows in cfs		
				Maximum	Minimum	Average
Missouri River at St. Joseph, Mo.	In St. Joseph	160	32	397,000	2,300	37,150
Platte River at Ravenwood, Mo.	1 mile downstream of Honey Creek	160	2	11,000	18	--
East Fork 102 River near Bedford, Iowa	¼ mile upstream of Daugherty Ck.	79-82-13	1	5,400	0.2	--
102 River near Maryville, Mo.	3½ miles downstream from Norvey Ck.	79-59	28	14,200	0	190
Platte River near Agency, Mo.	3½ miles NE of Agency, Mo.	66	33	50,000	0	783
Jenkins Branch at Gower, Mo.	0.8 miles north of Gower		10	1,730	0	1.13

*River Miles are approximate

[1]Data are from Geological Survey Water Supply Paper 1710, Part 6-B Surface Water Supply of the United States, 1960

Exhibit No. 2

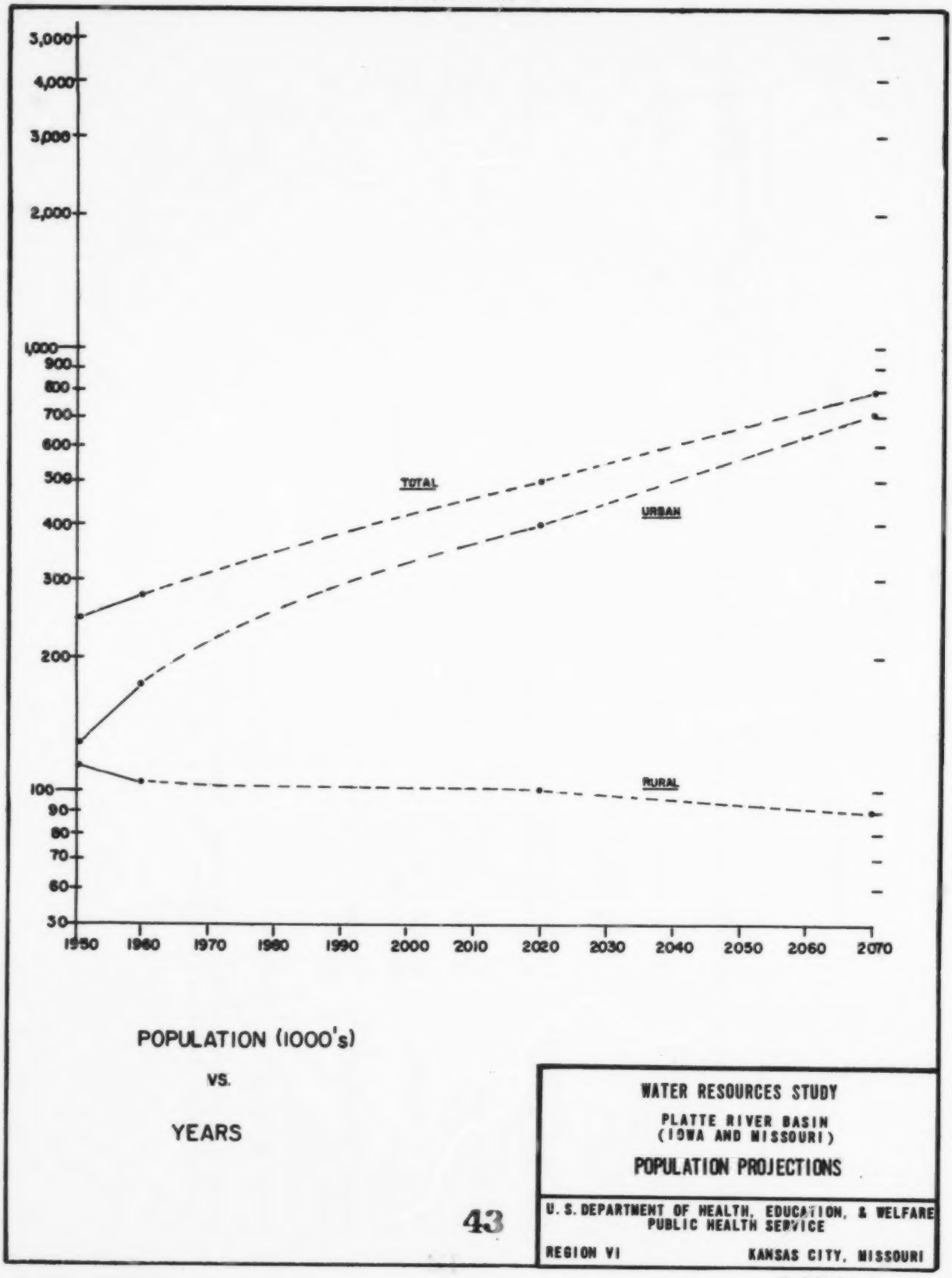

Exhibit No. 2

Exhibit No. 3

Municipal Water Supplies

Platte River Basin Study Area (Missouri & Iowa)

State County Municipality	1960 Population	1963 Population Served	Water Treatment	Source of Supply	Maximum* Dependable Draft (mgd)	Average Output (mgd)	gpcd
MISSOURI							
Nodaway County							
Hopkins	710	600	None	Three Wells	0.140	0.020	33
Maryville	7,807	8,000	Aeration, Coag., Chlor.	Pumped from 102 R. to Impoundment	(60)	0.900	112
Gentry County							
King City	1,009	1,050	Aeration, Coag., Chlor.	Two Impoundments	--	0.100	95
DeKalb County							
Union Star	392	500	Aeration, Chlorination	Two Wells	.036	0.025	50
Stewartsville	466	400	Softening, Chlorination	Two Wells	0.035	0.010	25
Clinton County							
Gower	406	450	Chlorination	Three Wells	0.056	0.015	33
Plattsburg	1,663	1,460	Aeration, Coag., Chlor.	Two Impoundments	(70)	0.080	55
Clay County							
Smithville	1,254	1,200	Coagulation, Chlorination	Impoundment & Creek	(26)	0.115	96
Platte County							
Edgerton	449	430	Aeration, Chlorination	Two Wells	.070	0.020	47
Dearborn	444	400	Coagulation, Chlorination	Impoundment	--	0.025	63
Platte City	1,188	1,200	Aeration, Coag., Chlor.	Three Wells	.310	0.135	112
Worth County							
Sheridan	277	300	Softening, Chlorination	Two Wells	0.130	0.014	47

Exhibit No. 3

Municipal Water Supplies

Platte River Basin Study Area (Missouri & Iowa)
(Cont.)

State County Municipality	1960 Population	1963 Population Served	Water Treatment	Source of Supply	Maximum* Dependable Draft (mgd)	Average Output (mgd)	gpcd
IOWA							
Taylor County							
Blockton	343	350E	Chlorination	Wells	.50	0.025	73
Bedford	1,807	2,000E	Aeration, Coag., Chlor.	East Fork of 102 R. and Impoundment	--	0.150	83
New Market	506	500E	Aeration	Drilled Well	0.070	0.020E	40
Lenox	1,178	1,200E	Coagulation, Chlorination	Impoundment	(116)	0.055	47
Union County							
Creston	7,667	7,800E	Coagulation, Chlorination	Impoundment	--	0.630	83
		27,840				2.339	84

*Numbers shown ( ) are million gallons impounded

Exhibit No. 3(2)

Exhibit No. 4

Typical Chemical Analyses of Water Resources

Platte River Basin Study Area (Missouri & Iowa)

(Results in Milligrams per Liter mg/l)

Location	Type*	Total Dissolved Solids	Chlorides (Cl^-)	Sulfates ($SO_4^=$)	Nitrate (N)	Hardness ($CaCO_3$)	Iron (Fe)	Remarks
Bedford, Ia.	M-R	341	10	123	1.0	228	<0.02	East 102 River
Blockton, Ia.	M-R	1,131	107	324	0.2	128	0.08	Town Well
Creston, Ia.	M-R	201	5	35	0.7	140	0.32	Summit Lake
Dearborn, Mo.	M-T	237	11	62	-	162	0.02	Surface water
Edgerton, Mo.	M-T	792	21	154	-	594	0.2	Wells
Gower, Mo.	M-T	416	8	36	-	300	0.5	Wells
Hopkins, Mo.	M-T	806	71	214	-	480	0.14	Wells
King City, Mo.	M-T	232	12	54	-	146	0.02	Impoundment
Lenox, Ia.	M-R	133	<0.5	17	0.4	88	0.44	Lake Inlet
Maryville, Mo.	M-T	289	14	54	-	160	0.02	102 River
New Market, Ia.	M-R	347	2	48	<0.1	236	4.4	Well
Platte City, Mo.	M-T	179	16	44	-	106	0.01	Wells
Plattsburg, Mo.	M-T	318	19	34	-	160	0.04	Surface water
Smithville, Mo.	M-T	431	12	142	-	262	0.02	Surface water
Stewartsville, Mo.	M-T	523	10	49	-	288	0.07	Wells
Union Star, Mo.	M-T	353	41	28	-	222	0.6	Wells

*Type
M - Municipal
R - Raw
T - Treated

Exhibit No. 4

Exhibit No. 5

Basic Data on Sources of Pollution

Platte River Basin Study Area (Missouri & Iowa)

Municipality	River Miles Above Mouth	1960 Population	1963 Sewered Population	P.E.(BOD) Before Treatment	Nature of Wastes	Treatment Provided	P.E. (BOD) Discharged	Watercourse
IOWA								
Bedford	79-82-13	1,807	1,750	4,000	Domestic & Industrial	Secondary	400	East Fork of 102 River
Creston	244	7,667	7,500	7,500	Domestic	Secondary	1,000	Creek to West Platte River
Lenox	79-82-34	1,178	800	800	Domestic	Lagoon	80E	East Fork of 102 River
MISSOURI								
Maryville (East Plant)	79-59	7,807	4,500	4,500	Domestic	Secondary	650	102 River
Maryville (S.W. Plant)	79-42-14-4	7,807	2,200	2,200	Domestic	Secondary	300	Creek to White Cloud Creek
Platte City	16	1,188	1,070	1,070	Domestic	Lagoon	100E	Platte River
Plattsburg	27-33-0.1	1,663	1,300	1,300	Domestic	Secondary	130	Horse Fork Creek to Little Platte River
Ravenwood	16-1E	282	250	250E	Domestic	Lagoon	25E	Branch of Platte River
Smithville	27-8E	1,254	1,200	1,200E	Domestic	Lagoon	120E	Little Platte River
			20,570	22,820			2,805	

E - Estimated

Exhibit No. 6

Computing Municipal and Industrial Water Supply Benefits

Platte River Basin Study Area (Missouri & Iowa)

Upper Area

1. Cost of alternative to supply 2.1 mgd is $680,450.
2. Amortized at 4% for 25 years (bonding period) = $43,556.
3. The present worth of 1 per period for 25 years at 3% = $758,447.
4. Amortized at 3% for 100 years to get average annual cost = $23,997.
5. Year of first need 2015; discounted at 3% for 45 years = $6,335.

Lower Area

1. Cost of alternative to supply 22.6 mgd is $9,500,000.
2. Amortized at 4% for 25 years (bonding period) = $608,095.
3. The present worth of 1 per period for 25 years at 3% = $10,588,843.
4. Amortized at 3% for 100 years to get average annual cost = $335,030.

Exhibit No. 7

Summary of Alternates for Water Quality Control

Platte River Basin Study Area (Missouri & Iowa)

Location	Item	Construction Cost $	Year of First Need	Amortized @ 3% for 100 years $	Annual Value Discounted @ 3% to 1970 $
UPPER AREA					
Creston	Pipe Line	2,851,200	1970	90,400	90,400
	Holding Pond	295,000	2005	9,350	3,300
				"Creston" total	93,700
Maryville & Bedford	Holding Pond at Bedford	149,700	1970	4,700	4,700
	Holding Pond at Maryville	350,000	2005	11,100	3,900
	Rework Pond at Bedford	120,000	2020	3,800	900
	Annual Operation & Maintenance	3,000	1970	3,000	3,000
				"Maryville & Bedford" total	12,500
LOWER AREA	Pipe Line	3,241,280	2040	102,700	12,900
				"Upper and Lower" grand total	$119,100

Exhibit No. 7